

Amendments to the Claims:

The following listing of claims will replace all prior versions, and listings, of claims in the application.

1. (Currently Amended) Reconstruction method for reconstructing a first signal $(x(t))$ from a set of sampled values $(y_s[n], y(nT))$ generated by sampling a second signal $(y(t))$ at a sub-Nyquist rate and at uniform intervals, ~~comprising the step of~~ the method comprising:

retrieving from said set of sampled values a set of shifts (t_n, t_k) and weights (c_n, c_{nr}, c_k) with which said first signal $(x(t))$ can be reconstructed.

2. (Original) Reconstruction method according to claim 1, wherein said set of regularly spaced sampled values comprises at least $2K$ sampled values $(y_s[n], y(nT))$,

wherein the class of said first signal $(x(t))$ is known,

wherein the bandwidth $(B, |\omega|)$ of said first signal $(x(t))$ is higher than $\omega_m = \pi/T$, T being the sampling interval,

wherein the rate of innovation (ρ) of said first signal $(x(t))$ is finite,

wherein said first signal is faithfully reconstructed from said set of sampled values by solving a structured linear system depending on said known class of signal.

3. (Original) Reconstruction method according to claim 1, wherein the reconstructed signal $(x(t))$ is a faithful representation of the sampled signal $(y(t))$ or of a signal $(x_i(t))$ related to said sampled signal $(y(t))$ by a known transfer function $(\phi(t))$.

4. (Original) Reconstruction method according to claim 3, wherein said transfer function ($\phi(t)$) includes the transfer function of a measuring device (7, 9) used for acquiring said second signal ($y(t)$) and/or of a transfer channel (5) over which said second signal ($y(t)$) has been transmitted.
5. (Original) Reconstruction method according to claim 1, wherein the reconstructed signal ($x(t)$) can be represented as a sequence of known functions ($\gamma(t)$) weighted by said weights (c_k) and shifted by said shifts (t_k).
6. (Original) Reconstruction method according to claim 1, wherein the sampling rate is at least equal to the rate of innovation (ρ) of said first signal ($x(t)$).
7. (Original) Reconstruction method according to claim 1, wherein a first system of equations is solved in order to retrieve said shifts (t_k) and a second system of equations is solved in order to retrieve said weights (c_k).
8. (Original) Reconstruction method according to claim 7, wherein the Fourier coefficients ($X[m]$) of said sample values ($y_s[n]$) are computed in order to define the values in said first system of equations.
9. (Original) Reconstruction method according to claim 1, including the following steps:
finding at least 2K spectral values ($X[m]$) of said first signal ($x(t)$),

using an annihilating filter for retrieving said arbitrary shifts (t_n, t_k) from said spectral values ($X[m]$).

10. (Original) Reconstruction method according to claim 1, wherein said first signal ($x(t)$) is a periodic signal with a finite rate of innovation (ρ).

11. (Original) Reconstruction method according to claim 10, wherein said first signal ($x(t)$) is a periodical piecewise polynomial signal, said reconstruction method including the following steps:

finding $2K$ spectral values ($X[m]$) of said first signal ($x(t)$),

using an annihilating filter for finding a differentiated version ($x^{R+1}(t)$) of said first signal ($x(t)$) from said spectral values,

integrating said differentiated version to find said first signal.

12. (Original) Reconstruction method according to claim 10, wherein said first signal ($x(t)$)

is a finite stream of weighted Dirac pulses $(x(t) = \sum_{k=0}^{K-1} c_k \delta(t - t_k))$, said reconstruction method

including the following steps:

finding the roots of an interpolating filter to find the shifts (t_n, t_k) of said pulses, solving a linear system to find the weights (amplitude coefficients) (c_n, c_k) of said pulses.

13. (Currently Amended) Reconstruction method according to claim 1, wherein said first signal ($x(t)$) is a finite length signal with a finite rate of innovation $[[\rho]]$.

14. (Original) Reconstruction method according to claim 13, wherein said reconstructed signal $x(t)$ is related to the sampled signal $y(t)$ by a sinc transfer function $(\varphi(t))$.
15. (Original) Reconstruction method according to claim 13, wherein said reconstructed signal $x(t)$ is related to the sampled signal $y(t)$ by a Gaussian transfer function $(\varphi_{\sigma}(t))$.
16. (Original) Reconstruction method according to claim 1, wherein said first signal $x(t)$ is an infinite length signal in which the rate of innovation (ρ, ρ_T) is locally finite, said reconstruction method comprising a plurality of successive steps of reconstruction of successive intervals of said first signal $x(t)$.
17. (Original) Reconstruction method according to claim 16, wherein said reconstructed signal $x(t)$ is related to the sampled signal $y(t)$ by a spline transfer function $(\varphi(t))$.
18. (Original) Reconstruction method according to claim 16, wherein said first signal $x(t)$ is a bilevel signal.
19. (Original) Reconstruction method according to claim 16, wherein said first signal $x(t)$ is a bilevel spline signal.
20. (Original) Reconstruction method according to claim 1, wherein said first signal $x(t)$ is a CDMA or a Ultra-Wide Band signal.

21. (Original) Circuit for reconstructing a sampled signal $(x(t))$ by carrying out the method of claim 1.

22. (Currently Amended) A computer-readable medium on which is recorded a control program for a data processor, the computer-readable medium comprising instructions for causing the data processor to:

reconstruct a first signal $(x(t))$ from a set of sampled values $(y_s[n], y(nT))$ generated by sampling a second signal $(y(t))$ at a sub-Nyquist rate and at uniform intervals, by retrieving from said set of sampled values a set of shifts (t_n, t_k) and weights (c_n, c_{nr}, c_k) with which said first signal $(x(t))$ can be reconstructed.

~~Computer program product directly loadable into the internal memory of a digital processing system and comprising software code portions for performing the method of claim 1 when said product is run by said digital processing system.~~

23. (Currently Amended) Sampling method for sampling a first signal $(x(t))$, wherein said first signal $(x(t))$ can be represented over a finite time interval (τ) by the superposition of a finite number (K) of known functions $(\delta(t), \gamma(t), \gamma_r(t))$ delayed by arbitrary shifts (t_n, t_k) and weighted by arbitrary amplitude coefficients (c_n, c_k) , said method comprising:

convoluting said method comprising the convolution of said first signal $(x(t))$ with a sampling kernel $((\phi(t), \phi(t))$ and using a regular sampling frequency $(f, 1/T)$,

choosing said sampling kernel $((\phi(t), \phi(t))$ and said sampling frequency $(f, 1/T)$ being chosen such that the sampled values $(y_s[n], y(nT))$ completely specify said first signal $(x(t))$, allowing a perfect reconstruction of said first signal $(x(t))$, and

reconstructing said first signal $(x(t))$,

wherein ~~characterized in that~~ said sampling frequency $(f, 1/T)$ is lower than the frequency given by the Shannon theorem, but greater than or equal to twice said finite number (K) divided by said finite time interval (τ) .

24. (Original) Sampling method according to claim 23, wherein said first signal $(x(t))$ is not bandlimited, and wherein said sampling kernel $(\phi(t))$ is chosen so that the number of non-zero sampled values is greater than $2K$.

25. (New) An apparatus for reconstructing a first signal $(x(t))$ from a set of sampled values $(y_s[n], y(nT))$, comprising:

a sampling device configured to generate the set of sampled values $(y_s[n], y(nT))$ via sampling a second signal $(y(t))$ at a sub-Nyquist rate and at uniform intervals; and

a reconstruction device configured to retrieve from said set of sampled values a set of shifts (t_n, t_k) and weights (c_n, c_{nr}, c_k) with which said first signal $(x(t))$ can be reconstructed.

26. (New) The apparatus according to claim 25, wherein said set of regularly spaced sampled values comprises at least $2K$ sampled values $(y_s[n], y(nT))$,

wherein the class of said first signal $(x(t))$ is known,

wherein the bandwidth $(B, |\omega|)$ of said first signal $(x(t))$ is higher than $\omega_m = \pi/T$, T being the sampling interval,

wherein the rate of innovation (ρ) of said first signal $(x(t))$ is finite, and

wherein said first signal is faithfully reconstructed from said set of sampled values by solving a structured linear system depending on said known class of signal.

27. (New) The apparatus according to claim 25, wherein the reconstructed signal $(x(t))$ is a faithful representation of the sampled signal $(y(t))$ or of a signal $(x_i(t))$ related to said sampled signal $(y(t))$ by a known transfer function $(\varphi(t))$.

28. (New) The apparatus according to claim 27, wherein said transfer function $(\varphi(t))$ includes the transfer function of a measuring device (7, 9) used for acquiring said second signal $(y(t))$ and/or of a transfer channel (5) over which said second signal $(y(t))$ has been transmitted.

29. (New) The apparatus according to claim 25, wherein the reconstructed signal $(x(t))$ can be represented as a sequence of known functions $(\gamma(t))$ weighted by said weights (c_k) and shifted by said shifts (t_k) .

30. (New) The apparatus according to claim 25, wherein the sampling rate is at least equal to the rate of innovation (ρ) of said first signal $(x(t))$.

31. (New) The apparatus according to claim 25, wherein a first system of equations is solved in order to retrieve said shifts (t_k) and a second system of equations is solved in order to retrieve said weights (c_k) .

32. (New) The apparatus according to claim 31, wherein the Fourier coefficients $(X[m])$ of

said sample values ($y_s[n]$) are computed in order to define the values in said first system of equations.

33. (New) The apparatus according to claim 25, further comprising:

a filter configured to find at least 2K spectral values ($X[m]$) of said first signal ($x(t)$); and
an annihilating filter configured to retrieve said arbitrary shifts (t_n, t_k) from said spectral values ($X[m]$).

34. (New) The apparatus according to claim 25, wherein said first signal ($x(t)$) is a periodic signal with a finite rate of innovation (ρ).

35. (New) The apparatus according to claim 34, wherein said first signal ($x(t)$) is a periodical piecewise polynomial signal, the apparatus further comprising:

a filter configured to find 2K spectral values ($X[m]$) of said first signal ($x(t)$);
an annihilating filter configured to find a differentiated version ($x^{R+1}(t)$) of said first signal ($x(t)$) from said spectral values; and
an integrator configured to integrate said differentiated version to find said first signal.

36. (New) The apparatus according to claim 34, wherein said first signal ($x(t)$) is a finite

stream of weighted Dirac pulses $(x(t) = \sum_{k=0}^{K-1} c_k \delta(t - t_k))$, the apparatus further comprising:

a filter configured to find the roots of an interpolating filter to find the shifts (t_n, t_k) of said pulses, and solve a linear system to find the weights (c_n, c_k) of said pulses.

37. (New) The apparatus according to claim 25, wherein said first signal $x(t)$ is a finite length signal with a finite rate of innovation (ρ).
38. (New) The apparatus according to claim 37, wherein said reconstructed signal $x(t)$ is related to the sampled signal $y(t)$ by a sinc transfer function $(\varphi(t))$.
39. (New) The apparatus according to claim 37, wherein said reconstructed signal $x(t)$ is related to the sampled signal $y(t)$ by a Gaussian transfer function $(\varphi_\sigma(t))$.
40. (New) The apparatus according to claim 25, wherein said first signal $x(t)$ is an infinite length signal in which the rate of innovation (ρ, ρ_T) is locally finite, wherein the reconstruction device is further configured to reconstruct successive intervals of said first signal $x(t)$.
41. (New) The apparatus according to claim 40, wherein said reconstructed signal $x(t)$ is related to the sampled signal $y(t)$ by a spline transfer function $(\varphi(t))$.
42. (New) The apparatus according to claim 40, wherein said first signal $x(t)$ is a bilevel signal.
43. (New) The apparatus according to claim 40, wherein said first signal $x(t)$ is a bilevel spline signal.

44. (New) The apparatus according to claim 25, wherein said first signal $(x(t))$ is a CDMA or a Ultra-Wide Band signal.

45. (New) An apparatus for reconstructing a first signal $(x(t))$ from a set of sampled values $(y_s[n], y(nT))$, comprising:

means for generating the set of sampled values $(y_s[n], y(nT))$ by sampling a second signal $(y(t))$ at a sub-Nyquist rate and at uniform intervals; and

means for retrieving from said set of sampled values a set of shifts (t_n, t_k) and weights (c_n, c_k) with which said first signal $(x(t))$ can be reconstructed.

46. (New) An apparatus for sampling a first signal $(x(t))$, wherein said first signal $(x(t))$ can be represented over a finite time interval (τ) by the superposition of a finite number (K) of known functions $(\delta(t), \gamma(t), \gamma_r(t))$ delayed by arbitrary shifts (t_n, t_k) and weighted by arbitrary amplitude coefficients (c_n, c_k) , said method comprising:

a filter configured to convolute said first signal $(x(t))$ with a sampling kernel $((\varphi(t), \varphi(t))$ and using a regular sampling frequency $(f, 1/T)$;

a sampling device configured to choose said sampling kernel $((\varphi(t), \varphi(t))$ and said sampling frequency $(f, 1/T)$ such that the sampled values $(y_s[n], y(nT))$ completely specify said first signal $(x(t))$; and

a reconstruction device configured to reconstruct said first signal $(x(t))$,

wherein said sampling frequency $(f, 1/T)$ is lower than the frequency given by the Shannon theorem, but greater than or equal to twice said finite number (K) divided by said finite time interval (τ) .

47. (New) The apparatus according to claim 46, wherein said first signal $x(t)$ is not bandlimited, and wherein said sampling kernel $\phi(t)$ is chosen so that the number of non-zero sampled values is greater than $2K$.

48. (New) A computer-readable medium on which is recorded a control program for a data processor, the computer-readable medium comprising instructions for causing the data processor to:

sample a first signal $x(t)$, wherein said first signal $x(t)$ can be represented over a finite time interval (τ) by the superposition of a finite number (K) of known functions $(\delta(t), \gamma(t), \gamma_r(t))$ delayed by arbitrary shifts (t_n, t_k) and weighted by arbitrary amplitude coefficients (c_n, c_k) ;

convolute said first signal $x(t)$ with a sampling kernel $(\phi(t), \phi(t))$ and using a regular sampling frequency $(f, 1/T)$;

choose said sampling kernel $(\phi(t), \phi(t))$ and said sampling frequency $(f, 1/T)$ such that the sampled values $(y_s[n], y(nT))$ completely specify said first signal $x(t)$; and

reconstruct said first signal $x(t)$,

wherein said sampling frequency $(f, 1/T)$ is lower than the frequency given by the Shannon theorem, but greater than or equal to twice said finite number (K) divided by said finite time interval (τ) .

49. (New) An apparatus for sampling a first signal $x(t)$, wherein said first signal $x(t)$ can be represented over a finite time interval (τ) by the superposition of a finite number (K) of

known functions ($\delta(t)$, $\gamma(t)$, $\gamma_r(t)$) delayed by arbitrary shifts (t_n , t_k) and weighted by arbitrary amplitude coefficients (c_n , c_k), said method comprising:

means for convoluting said first signal ($x(t)$) with a sampling kernel ($\phi(t)$, $\phi(t)$) and using a regular sampling frequency (f , $1/T$);

means for choosing said sampling kernel ($\phi(t)$, $\phi(t)$) and said sampling frequency (f , $1/T$) such that the sampled values ($y_s[n]$, $y(nT)$) completely specify said first signal ($x(t)$); and

means for reconstructing said first signal ($x(t)$),

wherein said sampling frequency (f , $1/T$) is lower than the frequency given by the Shannon theorem, but greater than or equal to twice said finite number (K) divided by said finite time interval (τ).